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Study of the Shipping Flow of the PattumbukangFerry Port, Selayar Islands Regency South Sulawesi

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Abstract

The Pattumbukang Ferry Port is one of the ferry ports in the Selayar Archipelago, South Sulawesi. This port is located in a small bay which results in several problems related to sedimentation and narrowing of the water area. To prevent silting due to existing sedimentation, it is necessary to carry out shipping channelplanning and dredging the seabed to obtain the required depth. The purpose of this study was to determine the hydro-oceanographic conditions at the Pattumbukang Ferry Port which was then used as a source of information regarding the depth and planning of water levels for material for evaluating shipping lane planning and estimating dredging volumes. Data collection in this study was carried out directly at the locationfor 15 days. Observations were made to obtain data in the form of: bathymetry data, tides, and soil sediment samples. The existing data is then processed and analyzed in shipping channel planning using assistance software, like :ArcGIS, Civilian 3D, Mapsource and software other supporters. Based on the results of the survey and processed data that has been carried out in this study, it can be concluded that: The existing condition of the shipping channel at the Pattumbukang Ferry Port does not meet the criteria based on the largest ship size, namely 1000 GT. Therefore, a one-way route planning is carried out with two alternative choices of channels where each alternative has its own advantages and disadvantages and with an ideal depthof 5.528≈ 6 m.

Keywords: Pattumbukang Ferry Port, Hydro-Oceanography, Shipping Channels, Dredging

1. Introduction

The Pattumbukang Ferry Port is one of the ferry ports in the Selayar Archipelago, South Sulawesi, to be precise, on the east side of the island. Based on the position of Pattumbukang Port itself, to be precise, it is located in a bay with relatively narrow water conditions, resulting in several obstacles related to the sedimentation process and narrowing of the shipping channel area. This is one of the main factors inhibiting shipping activities at the Pattumbukang Ferry Port. Therefore, further review is needed regarding the planning of shipping lanes at the Pattumbukang Crossing Cruise in order to smooth the activities of incoming/outgoing ships at the port.

Shipping channel planning activities cannot be separated from marine mapping survey work (bathymetric survey). The bathymetric survey provides an overview of the original elevation conditions from an actual depth which is visualized into a bathymetric map. The determination of the channel design is planned by taking into account several parameters, such as water conditions, tides, waves and so on. The purpose of this study was to determine the hydro-oceanographic and bathymetric conditions at the Pattumbukang Ferry Port which were then used as a source of information regarding depth and water level planning for evaluation of shipping channel planning.

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2. Materials and Methods

Data collection on the Pattumbukang Ferry Port shipping lane is carried out directly on location. Observations were made to obtain data in the form of bathymetry, tides, and sediment samples. The existing data is then processed using several software support, such as:Ms-Excel, Mapsource, ArcGIS, and Civilian 3D. The processed data will be analyzed to obtain a depth reference elevation as a consideration in shipping channel planning.

3. Results and Discussion

3.1. Hydro-Oceanographic Conditions

The existing hydro-oceanographic conditions at the Pattumbukang Ferry Port are treated as a reference material in planning shipping lanes and estimating dredged volumes. Data retrieval includes tidal, depth, and sediment data.

1. Tidal Data. Observation of tides in this activity was carried out for 15 days, namely September 27 2022 - October 11 2022 using time master as an automatic measuring instrument whose sensor is mounted on the tip measuring scale so that in addition to automatic measurements, manual observations are also made every hour. The tidal-forming components at the Pattumbukang Ferry Port location are calculated by harmonic analysis using the Least Square. Tidal constants atthe study location are the results of analysis with the method Least Square can be seen in Table1.

Table 1. Tidal Constants at the Pattumbukang Ferry Port

Constant	Period(s)	Phase (^{O})	Width (m)
Like this	0,00	0,00	1,58
M2	12,42	343,85	0,53
S2	12,00	280,78	0,15
N2	12,66	133,61	0,09
K2	11,97	195,25	0,03
K1	23,93	324,13	0,57
O1	25,82	186,75	0,33
P1	24,07	169,06	0,27

Where under the condition, 0 < F 0,25 is semidiurnal is 0,25 < F 1,50 is mixed tide prevailing semi- diurnal;1,50 < F 3,00 is mixed tide prevailing diurnal and F > 3,0 is diurnal. From the calculation results obtained the value of F (shape number) of 1.342, so that the type oftide at the Pattumbukang Ferry Port location is categorized as a mixed tide leaning towards double daily (mixed tide prevailing semi-diurnal) which means that there are 2 high tides and 2 low tides in one day. By using these parameters, forecasting the magnitude of the tides that produce the important elevation of the waters at the Pattumbukang Ferry Port location is as follows.

Table 2. Tidal Elevation at the Pattumbukang Ferry Port

Reference Elevation	Elevation (m)
Highest Astronomical Tide (HAT)	3,15
Mean Highest High Water Spring (MHHWS)	2,25
Mean Highest High Water Neap (MHWN)	1,96
Mean Sea Level (MSL)	1,58
Mean Lowest Low Water Neap (MLLWN)	1,20
Mean Lowest Low Water Spring (MLLWS)	0,90
Lowest Astronomical Tide (LAT)	0,00

2. Depth Data. A bathymetry survey to get an overview of the bottom contour of the waters at the

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study site was carried out using echo sounder. The method of carrying out the bathymetric survey is carried out by prior preparation, namely calibration and installation of tools on the survey vessel. Sounding is carried out at intervals ranging from 30 m – 50 m by following the sounding path that has been made before. Good ship maneuvers help in taking sounding points following the existing tracking, the closer the lines are made, the more difficult it is to maneuverthe ship but the results of the sounding itself are more accurate. The recording area points are then plotted on the sounding track map as a tracking bathymetric survey with the area of the waters± 2.80 km2 then the data from the results of the bathymetric survey sounding are processed to produce a sea depth map or a bathymetric map that has been corrected with tidesat intervals of -5 m which can be seen in Figure 1.

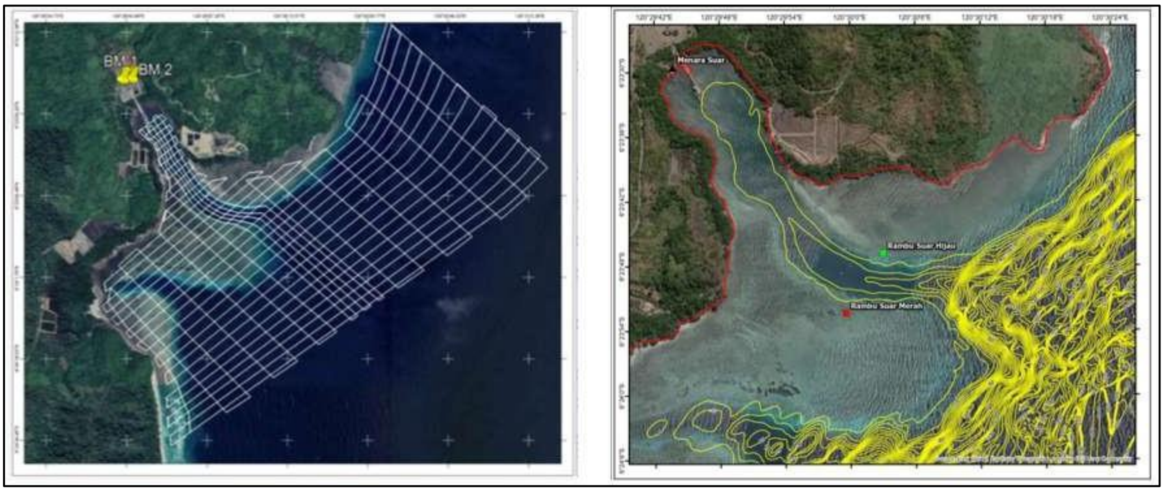

Fig.1. Map of the Pemuman Route and Bathymetry of the Waters of the Pattumbukang FerryPort

3. Sediment Data. Sediment sampling was carried out to determine the sedimentation conditions of the bottom of the waters at the study site. In this study, the sampling process was carried outusing a grab sampler. Bottom sediment samples taken at the location were stored in plastic containers and then brought to the laboratory for analysis of the grain gradation and density of each sample. Table 3 shows the laboratory results of the bottom sediments around the Pattumbukang Ferry Port area.

Table 3. Results of analysis of grain gradation and density of basic sediments

No	Grain Size	Sample Code					
		TS 1 (gram)	TS 2 (gram)	TS 3 (gram)	TS 4 (gram)	TS 5 (gram)	TS 6 (gram)
1	2 mm	0,087	3,431	3,689	2,838	3,547	2,605
2	1 mm	0,572	10,438	13,613	9,758	12,525	13,945
3	0,5 mm	3,037	16,435	16,453	10,772	15,031	12,437
4	0,25 mm	12,984	22,755	19,387	15,176	18,566	21,486
5	0,125 mm	57,549	25,877	31,306	38,309	29,832	35,990
6	0,063 mm	24,544	19,914	14,727	22,112	19,519	12,024
7	<0,063 mm	1,231	1,160	0,847	1,039	0,982	1,537
8	Final Weight	100,005	100,011	100,022	100,004	100,002	100,024
9	Initial Weight	100,087	100,090	100,094	100,090	100,034	100,045

After obtaining the weight of each grain at the sample location, a grain gradation analysis is carried out based on the percentage of passing through the sieve. The determination of soil type refers to the 50% passing percentage (D50) which can be seen in Table 3.

Based on soil data in the form of grain size and percentage of passing on the sieve, it is suspected

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that the type of soil at the Pattumbukang Ferry Port is medium sand (*medium sand*) refers to Table 4

Table 4. Diameter of 50% Offset Granules

Sample	D50 (mm)	Rate-Rate (mm)
TS 1	0,172	
TS 2	0,288	
TS 3	0,295	0,243
TS 4	0,204	
TS 5	0,245	
TS 6	0,252	

Table 5. Types of Soil Based on Grain Size

Kind of Land	Size Limit
Boulder	> 20 cm
cobblestone	(8 – 20) cm
gravel	2 mm – 8 cm
Rough sands	(0.6 – 2) mm
Medium sand	(0.2 – 0.6) mm
Fine Sand	(0.06 – 0.2) mm
silt (silt)	(0.002 – 0.06) mm
Clay (clay)	< 0.002

3.2. Shipping Channel Planning

Shipping channel planning is carried out based on the largest ship size with the dimensions of the planned ship with GT is 1.000 ton; Totally is 75,0 m; Width (B) is 13,4 m; Height (H) is 5,0 m and Sarat (T) is 4,0 m.

1. Harbor Pool Planning, The port pool should be calm, have enough width and depth, so that it allows ships to anchor safely and facilitate the loading and unloading of goods. Where Spin Pool Length Calculation is the area of the turning pool used to change the minimum ship's direction is the area of a circle with a radius of 1.2 times the total length of the ship (Loa) of the largest ship using it.

   $R = 1{,}2 \times \text{Total}$

   $= 90$ m

   $A_{pool} = \pi r^2$

   $= 25.457{,}14$ m^2

2. Harbor Pool Depth. Taking into account the ship's isolation motion due to natural influences such as waves, wind and tidal currents, the depth of the harbor pool is 1.1 times draft the ship is fully loaded below the design water level. Thus, the minimum depth of the rotating pool is obtained:

   $dp = 1{,}1 \times D$

   $= 4{,}4 \approx 5$ m

It is planned that the minimum depth of the rotating pool is 5.0 meters.

3. Port Channel Planning. After carrying out the analysis based on the results of the bathymetry map and direct observation at the research location, the shipping channel planning data is obtained:

a. Flow Width Planning, as for planning the width of shipping lanes, one-lane channel width is used, with reference to the following equation:

$L = 1{,}5B + 1{,}8B + 1{,}5B$

$= 64{,}32 \approx 65$ m

b. Groove Depth. In order to meet the required depth, then planned groove depth with to calculate the net depth:

$\Delta T = \Delta T_1 + \Delta T_2 + \Delta T_3 + \Delta T_4$

Where, ΔT is *net clearance* (m), ΔT_1 is soil condition factor with value 68,96 m ≈ 69 m, ΔT_2 is wave factor with value 0.328 m, ΔT_3 is ship motion factor with value 0,088 m and ΔT_4 is settling factor with this factor is due to the presence of deposits, because the shipping channel is in the middle of the high seas. Thus, the precipitate value is assumed to be small and can be neglected. So based on the calculation above, it is obtained ΔT_{total} is 1,528 m. So, H_{max} which is taken is:

$$H_{max} = Draft + Net\ clearance$$
$$= 5{,}528\ \text{m}$$

H_{max}The current depth of the groove has not been fulfilled due to the existing depth (≥ 4 m) less than the calculated depth (H_{max}) 5,528 m ≈ 6 m.

c. Shipping Channel Length and Route.
Condition*route*The flow at the turn is:

$R > 3$ L, for $\alpha < 25^O$

$R > 5$ L, for $25^O < \alpha < 35^O$

$R > 10$ L for$\alpha > 35^O$

Where R is radius of turn, L is ship length, α is turning angle. From the previous calculation, it was found that the width of the channel for one shipping line was 65 m. So for the design of the shipping channel plan that turns, the radius of the bend is R ≥ 10L, namely R = 750 m because the angle of the bend obtained is α = 39°

d. Groove Slope. The side of the shipping channel is made with a certain slope which is used to minimize landslides on the side of the channel. The slope of the groove sides varies depending on the type of material. To determine the type of soil used based on grain size, the soil in Pattumbukang is included in the classification of sand with moderate soil types with grain variations close to soft soil, so the slope used is 1: 3.

e. Design of the Pattumbukang Ferry Port Shipping Channel. Based on the results of the analysis and data processing, the layout of the shipping lanes of the Pattumbukang Ferry Port is plannedwith 2 alternative options.

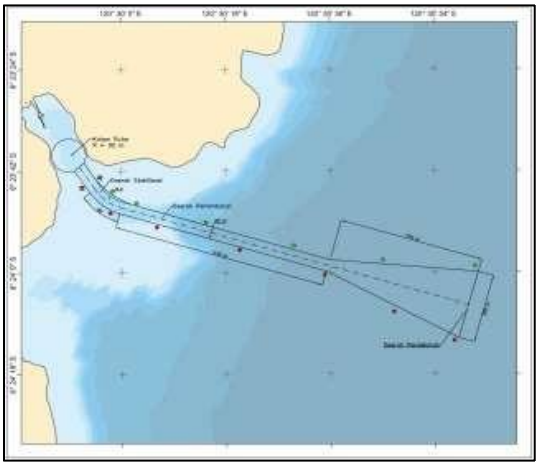

Fig. 2. Layout of Alternative Shipping Channels 1 of the Pattumbukang Crossing Port

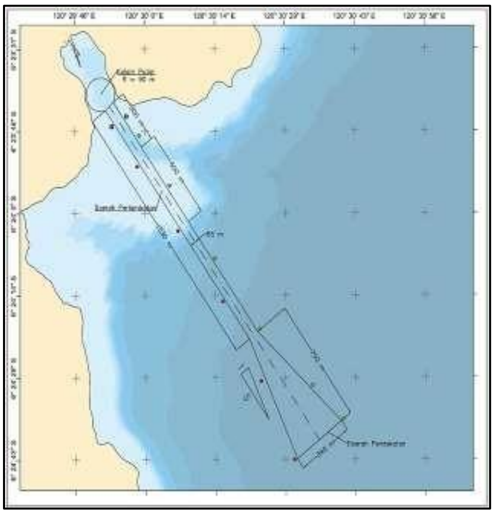

Fig. 3. Layout of Alternative Shipping Channels for 2 Pattumbukang Crossing Ports

4. Conclusion

Based on the survey results and data processing that has been carried out in this study, it can be concluded is the existing condition of the shipping lanes at the Pattumbukang Ferry Port has notmet the criteria based on the size of the largest ship with a cargo capacity of 1000 GT and based on the processed existing data, so that a one-way route planning is carried out with 2 alternative choices of routes with an ideal depth of 5.528≈ 6 m.

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